Chapter 8

Roller Mills

Roller Mills

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VA 94/4167/E

1.   INTRODUCTION

The vertical roller mill is the appropriate equipment for grinding and drying of wet materials. Grinding and drying can very efficiently be executed in one machine:

Many materials can be ground in vertical roller mills such as:

* raw materials
* coal
* pozzolana / trass
* slag
* (cement)

This paper deals in first place with roller mills for raw material processing. For grinding coal, slag, cement, etc., adaptations to mills and systems have to be made.

2.   FUNCTIONS OF THE ROLLER MILL

The vertical roller mill fulfills 4 main functions in one compact piece of equipment:

◆ Grinding

◆ Drying

◆ Separation

◆ Transport

The process is called a drying / grinding process, where most of the material / product is transported pneumatically by drying gases.

◆ **Grinding:**
The material is ground between rollers and grinding table while passing from the center of the table to the nozzle ring. The comminution method belongs to the most efficient grinding processes applied in the cement manufacturing.

◆ **Separation:**
The ground and dried material is lifted up with the drying gases. In the separator, the too coarse particles (tailings) are rejected to the grinding table. The fines leave the mill and are conveyed to a dust collector.

◆ **Drying:**
The process air consists mostly of waste gas from a kiln or cooler or is supplied by a hot gas generator. Drying occurs during transport through the grinding and separating process stage.

◆ **Transport:**
The drying gases are utilized to serve as conveying media. The first transport stage is the internal circulation and the second the separator. At last, the product is extracted from the separator and pneumatically conveyed to cyclones or a filter where the product is collected and fed to a silo. The clean gases are exhausted to the ambient and/or recirculated to the mill.

Figure 1   Functions.
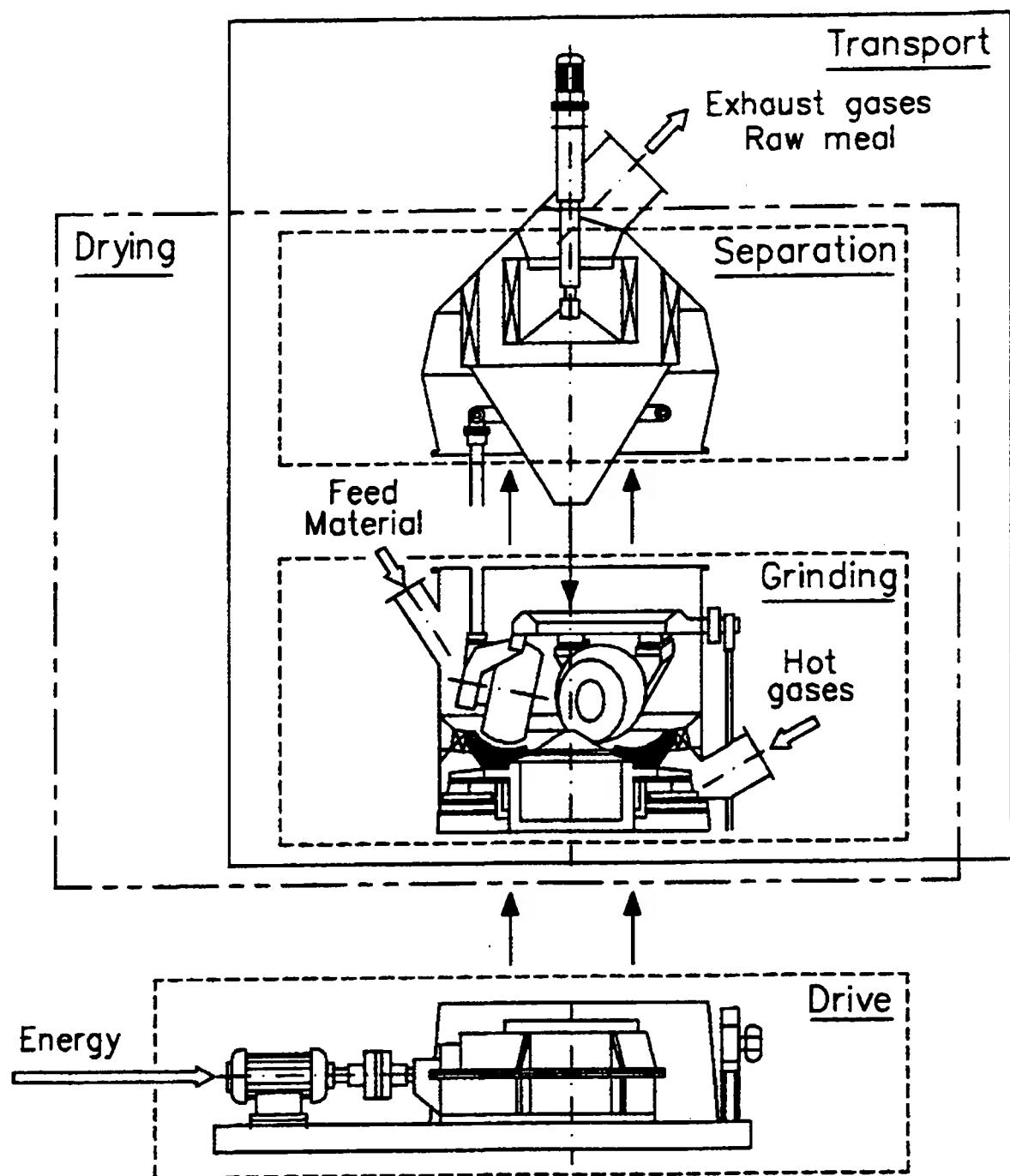
Figure 2   General Design.
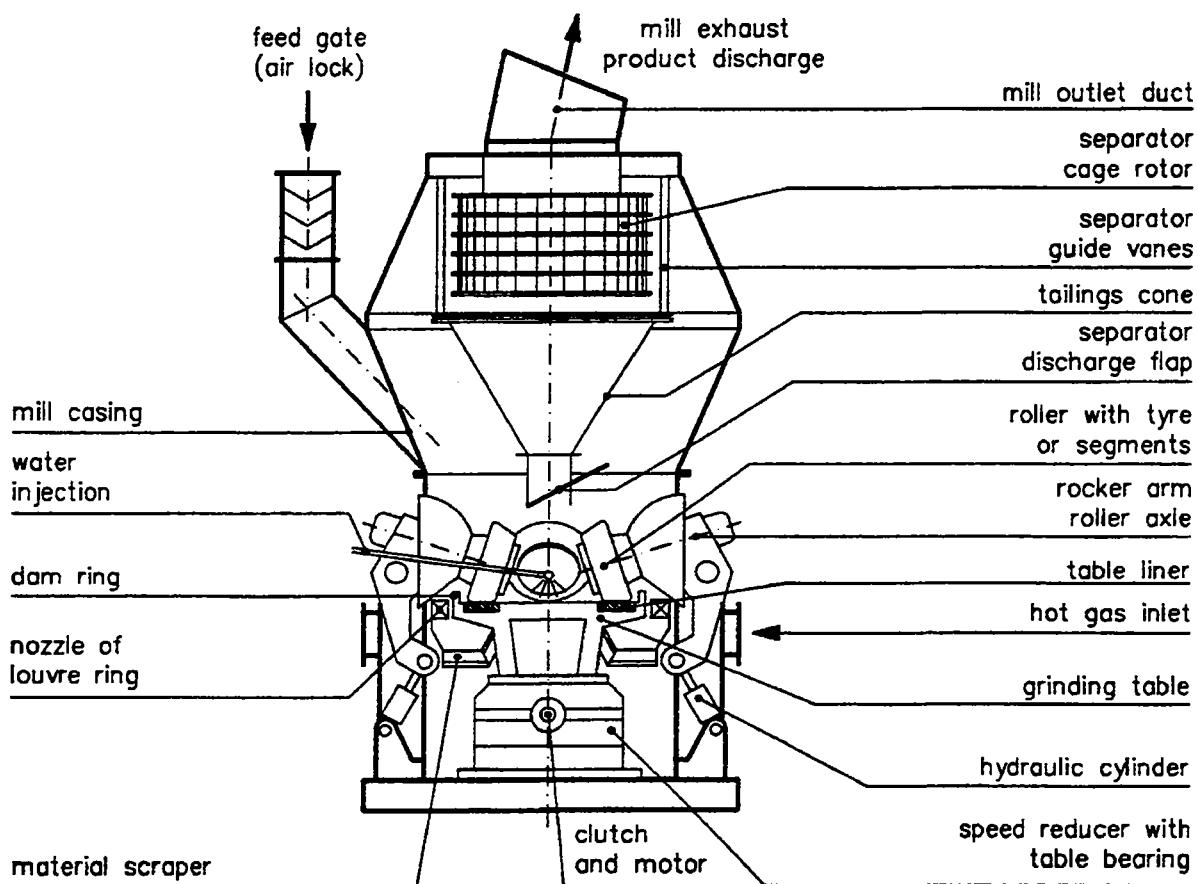
3.   GENERAL DESIGN AND WORKING PRINCIPLES

♦ **Material feed:**

The wet material is fed through an air sealed feed gate onto the grinding table. The feed gate has to avoid false air inlet to the mill and seal against a fairly high negative pressure in the mill body. For wet and sticky materials triple gates (heatable) are preferred, for general use rotary airlocks are commonly applied, depending on supplier's philosophies.

♦ **Grinding:**

The material (fresh feed, recirculating material and separator tailings) passes from the table center under the rollers. The material is drawn in-between roller and grinding track and is comminuted. Depending on the roller diameter, table speed, roller pressure and the material characteristics (granulometry and properties) a certain max. particle size can be drawn under the rollers (max. size = 5 - 8 [%] of roller diameter). Higher bed thicknesses require higher grinding pressures and thus absorb more power. More power is also absorbed with increasing material moistures.

The ability to form a stable grinding bed is essential for a stable mill operation. Dam rings are often utilized for adjustment of the grinding bed thickness. They serve as retention device for the material on the grinding table.

♦ **Material circulation:**

The material, which flows over the dam ring is caught by the vertical gas flow from the nozzle ring and lifted up. Coarser particles fall back to the grinding table and finer ones are swept up to the separator for being classified. The internal circulation rate depends mainly on the grindability of the ground material and can amount up to 15 - 25 cycles. Reducing the gas speed in the nozzle ring (adjustment of the open area) leads to falling through of larger particles. The fall through material has to be extracted with scrapers and mechanically recirculated to the mill feed.

♦ **Separation:**

The use of modern separators in roller mills is state of the art. A sharp separation improves the raw meal quality and avoids over grinding (saving of energy). Coarse tailings, fed through the tailings cone to the center of the grinding table, helps the formation of a more stable grinding bed. The raw meal fineness is easily controlled by adjustment of the cage rotor speed.

♦ **Drying:**

Drying occurs mainly where the hot gases exit the nozzles and enter in contact with the moist material. Fine particles have an extended retention time within the drying gases (up to the dust collector), which ensures a good drying performance. The drying rate, resp. drying need is directly reflected in the mill exhaust temperature.

♦ **Water injection:**

At certain conditions, roller mills need water injection to stabilize the grinding bed. Injection nozzles should spray onto the material in front of each roller, proportioned according to the throughput.

Water injection facilities with dosing valves can be installed in the mill casing to cool down the kiln gases in case of excess gas temperature and lack of material moisture.

Figure 3   Working Principle.

Grinding action

bed of ground material

compaction zone

bed of feed material

draw-in zone (acceleration)

D_R roller diameter

d   largest particle

v   speed

γ draw-in angle

α nip angle

β reaction angle

F   grinding force

max. particle size

$$\frac{d}{D_R} \leq 5 - 8 \ (\%)$$
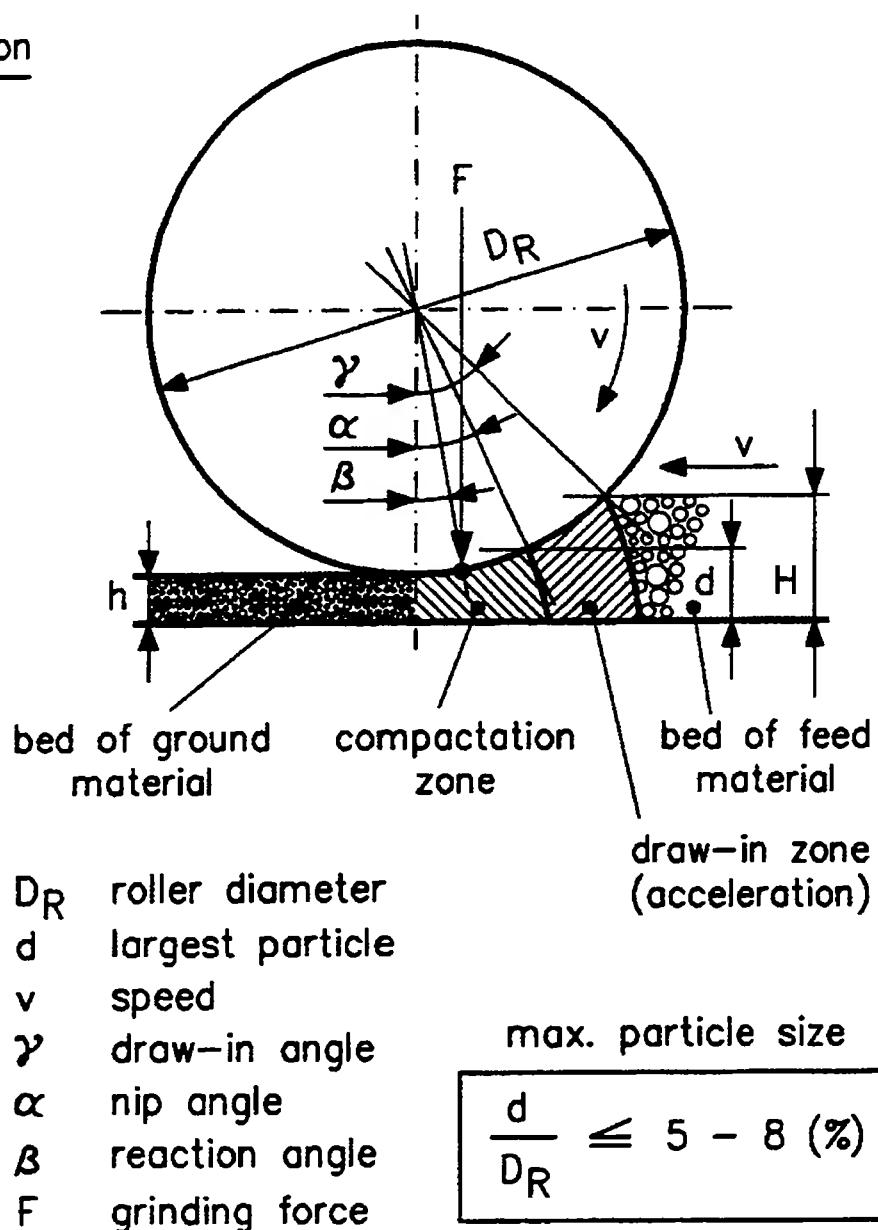
Figure 4   Internal Circulation.

Material circulation

product extraction

fresh feed

internal
circulation
(pneumatical)

tailings

coarses

fall through
material

gas

gas

material

mixture material/air

gas/air
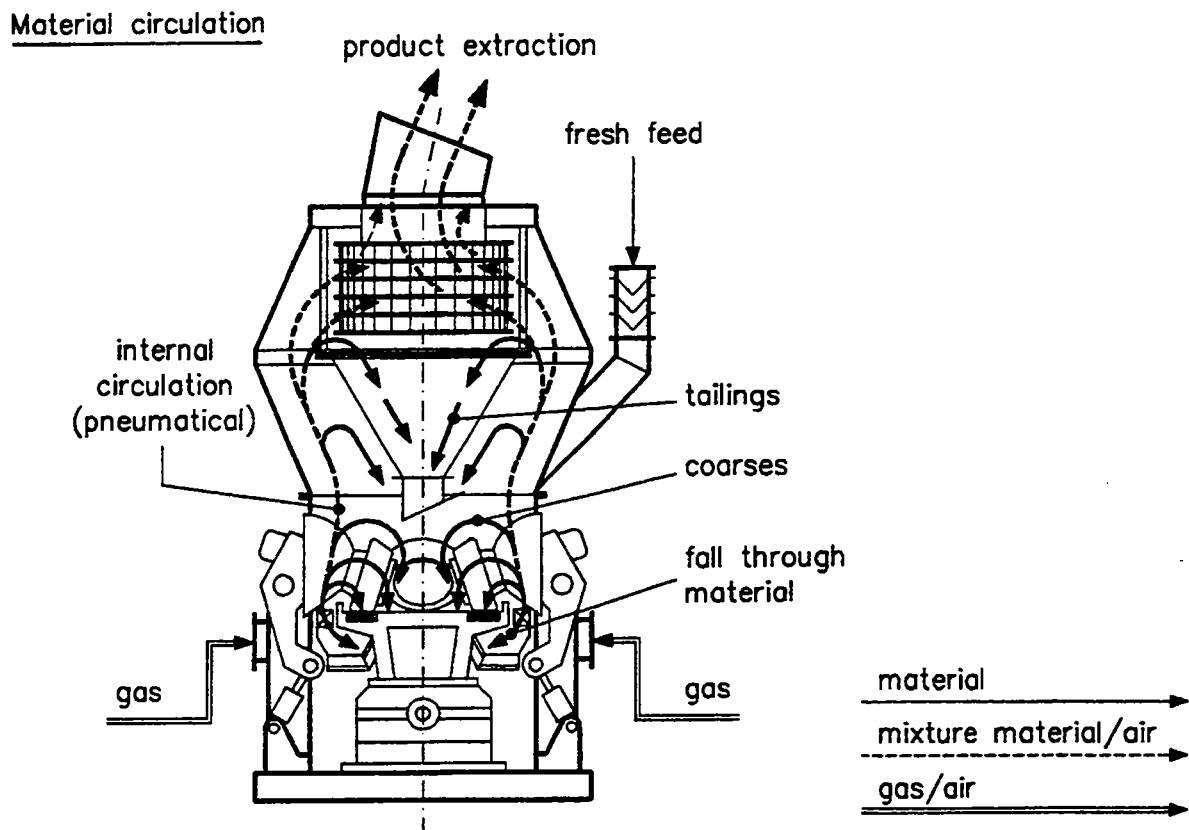
4.   DIMENSIONING AND DIMENSIONING CRITERIA

Two main aspects have to be considered when sizing a vertical roller mill:

* grinding
* drying

Which ever of the two is critical determines mainly the size of the mill.

* For the grinding needs, the grindability of the processed material (as a function of the material properties and the product fineness) requests a certain size of grinding table and rollers, as well as eventually the table speed.

* For the drying, the necessary gas flow rate (as a function of material moisture and available gas temperature) determines the casing diameter, the open section of nozzles and the separator size.

Mill throughput $\dot{M}$: is proportional to $D_M^{2.5}$ for given conditions and mill type.

Mill power absorbed P_{abs}: is a result of the required mill throughput and the grindability of the material under given conditions. The mill size is determined by solving formula 2) for D_M. The friction factor and the spec roller pressure are empirical values gained through experience and/or lab tests. The mill parameters are supplier specific and given in chapter 7. The absorbed power increases with higher material moisture, higher press forces and higher grinding bed thickness.

Installed power $P_{inst} = 1,1 \times P_{abs}$ [kW]

Specific roller pressure k: is defined by division of the total roller press force **F** by the projected roller section $D_R \times W_R$. Each mill type has its operating range. The achieved spec. roller pressure is related to the operating conditions.

Roller pressure force F: consists of the proper roller weight **G** and the exerted force by the hydraulic pressure device F_2. Force F_1 applies for rocker arm type mills, where the force from the hydraulic cylinder has to be converted to F_2 with the lever arm ratio.

Table speed n: is a function of D_M for a constant centrifugal force of the material on the grinding table. Typical speed constant **c** are given for each supplier. In certain cases, lower speeds are used for fine and dry feed materials.

Drying capacity: In general, the maximum drying capacity is around 20 [%] H_2O. For higher moisture contents a predrying facility is necessary. The required gas flow rate through the mill has to be calculated e.g. through a heat balance. The maximum admissible mill inlet temperature is < 450 [C].

Gas speeds: The mill has to be sized to meet the required speed ranges:

* Nozzle ring: ≥ 30 [m/s], higher speeds can be adjusted by covering nozzles
* Mill casing: 4.5 - 7 [m/s] for vertical transport
* Separator: 4.5 - 6 [m/s] through the cage rotor (gross area)

Dust load: The gas flow rate must be selected to achieve a dust load of 500 - 600 [g/m^3] raw meal at the mill outlet. The never exceed value for the separator and dust collector is 750 [g/m^3].

Separator speed: should be adjustable in the range of 10 - 25 [m/s] periferical cage rotor speed for raw mills.

Figure 5 **Dimensioning**

Mill throughput $\dot{M}$:

$$\dot{M} = \frac{P^{abs}}{q}$$

(t/h) ①

Absorbed mill power P_{abs}:

$$P^{abs} = i \cdot \mu \cdot k \cdot D_R \cdot W_R \cdot D_M \cdot \pi \frac{n}{60}$$

(kW) ②

Specific roller pressure k:

$$k = \frac{F}{DR \cdot WR}$$

(kN/m²) ③

Roller press force F:

$$F = F_2 + G_R$$

(kN) ④

Table speed n:

$$n = \frac{c}{\sqrt{D_M}}$$

(min⁻¹) ⑤
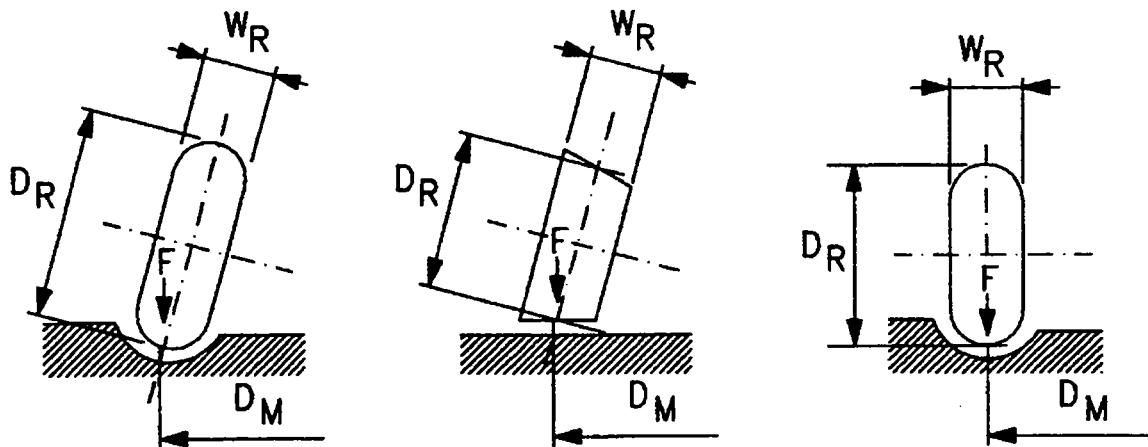
Symbol explanation

Symbol	Unit	Designation	Symbol	Unit	Designation
$\dot{M}$	(t/h)	Mill throughput	D_R	(m)	- roller
q	(kWh/t)	Spec. energy consumption	W_R	(m)	Roller width
P_{abs}	(kW)	Mill power, absorbed	F	(kN)	Roller press force
I	(-)	Number of rollers	F_1	(kN)	Mech. force at hydr. piston rod
μ	(-)	Friction factor	F_2	(kN)	Mech. force at roller
k	(kN/m^2)	Spec. roller pressure	G_R	(kN)	Roller weight
D	(m)	Diameter	c	(-)	Speed constant (supplier specific)
D_T	(m)	- table	n	(min^{-1})	Speed of grinding table
D_N	(m)	- nominal	v	(m/s)	any velocity
D_M	(m)	- grinding track			

5. OPERATIONAL ASPECTS

Grinding:

During operation the prime objective is to ensure an optimum and stable grinding bed which allows the optimum grinding production at the lowest absorbed mill power. The main influence factors are:

♦ **Material granulometry**: - A mixture of coarse and fine particles form a stable material bed. Too coarse material (car on gravel road) causes rough roller movements. Too fine material (car on a sandy ground) tends the rollers to slide or slip.
Too dry material is usually moistened by water injection to form a compact bed.

♦ **Roller pressure**: - High pressures yield a higher comminution work in one material passage and hence lead to lower circulation loads and vice versa. Pressure and circulating loads influence the particle size distribution of the product, higher circulating loads produce wider and lower circulating loads narrower particle size distributions. At higher pressures also the absorbed motor power increases. The optimal conditions have to be established by trials and experience.

♦ **Dam ring**: - The dam ring allows an adjustment of the bed height and is more important for mills with flat tables to retain the material on the grinding table. As the wear at rollers and table segments proceed, the grinding bed height increases. To keep the bed height constant, the dam ring height needs then to be lowered. When exchanging roller and table wear parts, the dam ring has generally also to be renewed accordingly.

♦ **Louvre ring**: - Based on the rollers arrangement and table design, the material reaches in uneven flows the louvre ring. By proper adjustment of the nozzle openings (covers, inserts, adjustment devices) more gas can be guided through the nozzles where more and coarse material has to be lifted up.

External circulation:

♦ The material is lifted up over the louvre ring by the gas flow and pneumatically recirculated. To lift up the larger particles, too much gas velocity is needed which causes high pressure loss across the louvre ring.

In order to reduce the pressure drop in this area, the open nozzle section is opened to provide speeds in the range of 30 - 50 [m/s] through the nozzles, with the result of reducing the fan power. As a result, coarse particles fall through the nozzles, have to be collected by a scraper attached to the rotating grinding table, and are lifted up mechanically (bucket elevator) to the mill feed. Bucket elevators are dimensioned for the same capacity as the mill throughput (100 [%]), even if during normal operation a lower rate is externally recirculated.

Figure 6   Grinding Aspects.

Material flow on the grinding table

feed material

grinding area

rotation
of table

ground material

open section of nozzles
to be adjusted by inserts
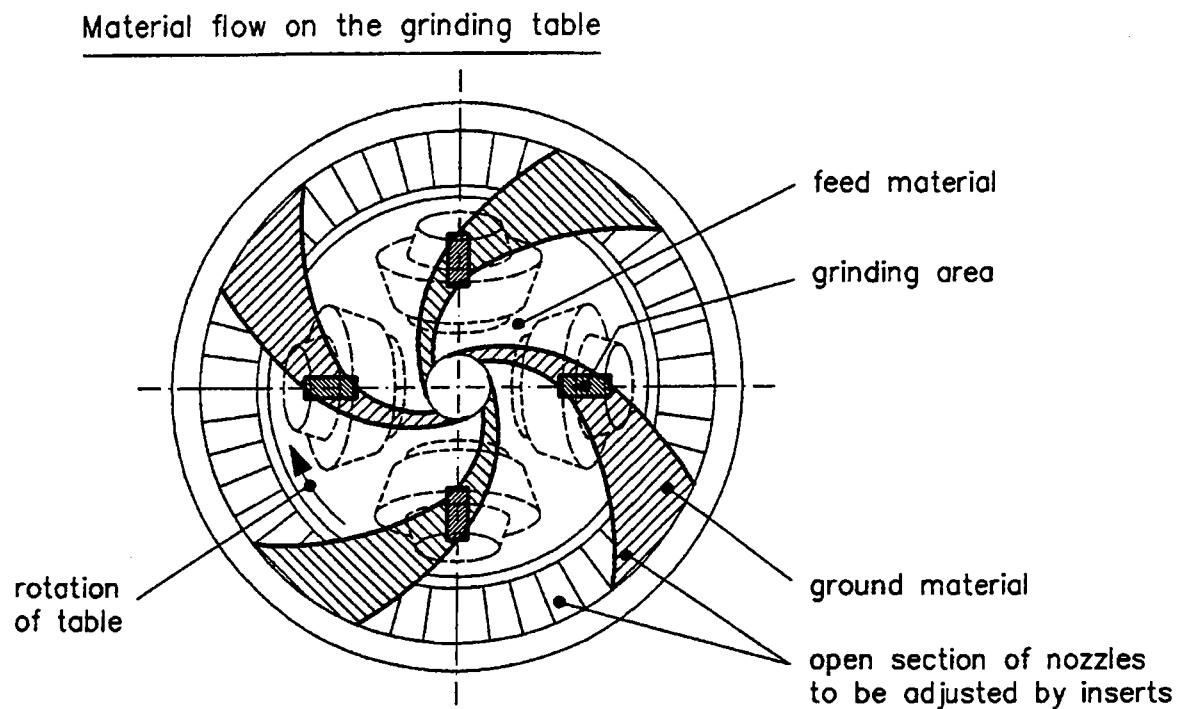
Figure 7   External Circulation.
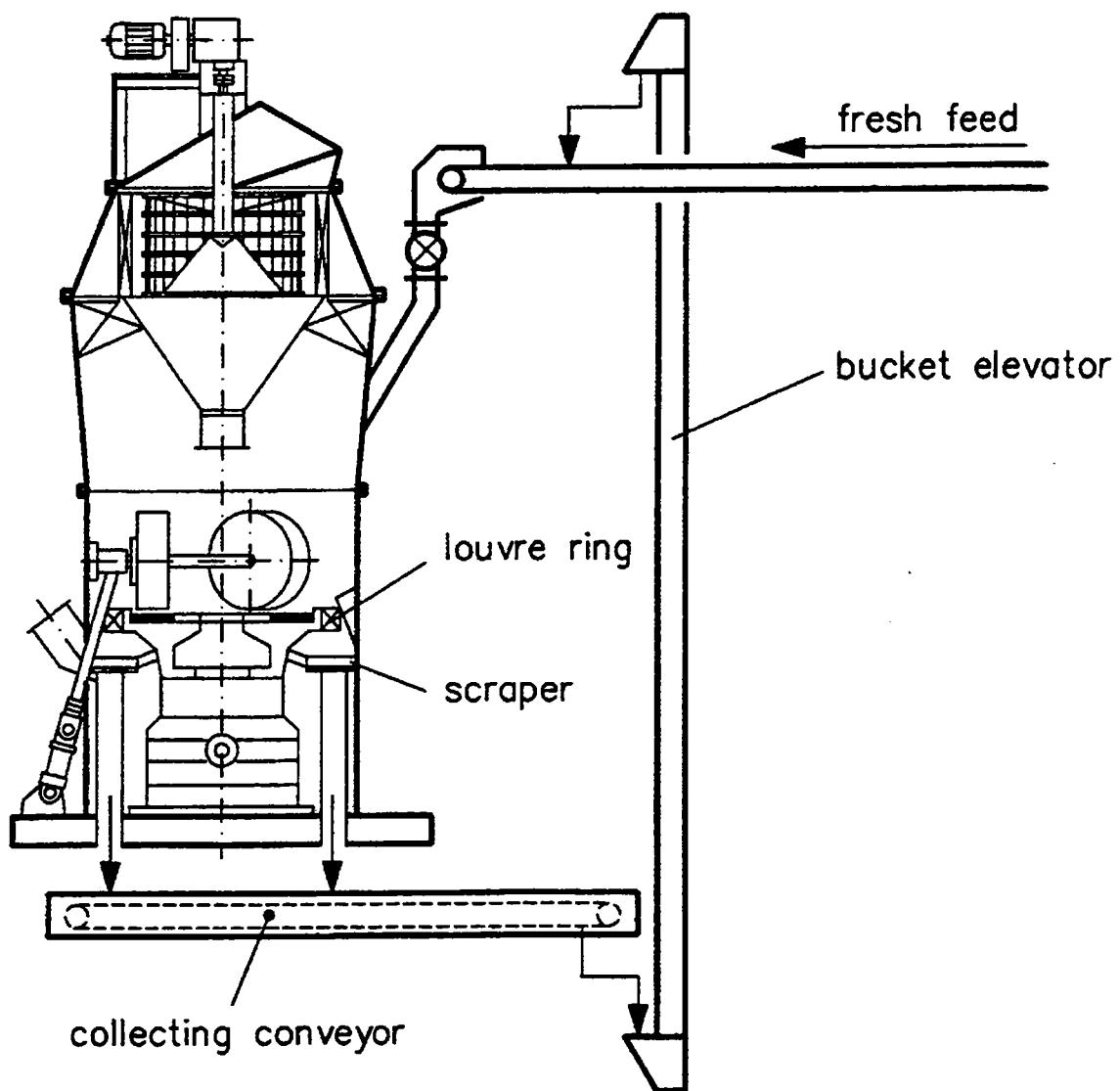
Separation:

♦ The separator has to classify the material lifted up from the grinding table. The separator acts mainly in the coarse fraction of the product. The fines are produced by the grinding process. The target is to produce a narrow particle size distribution (PSD) with a low amount of coarse (% R 200 μm) and fine particles (% < 10 μm).

♦ There are three generations of separators:
1. Generation: Static separators
2. Generation: Conventional rotor type separators
3. Generation: Cage rotor separators with guide vanes

♦ **Static separators** are cheap and simple equipments, but produce a wide PSD. Fineness adjustment is done by adjusting the direction of the vanes. The efficiency drops with increasing fineness (more tangential vane position, higher pressure loss, lower gas flow rate due to fan characteristic).

♦ **Conventional rotor type separators** adjust the fineness by the rotor speed. They produce a wide PSD. Low pressure loss. Tailings fall spreaded over the grinding table.

♦ **Cage rotor separators with guide vanes** are based on the same considerations as commonly used for cement grinding, but have to operate with higher air speeds through the cage rotor (4.5 - 6 [m/s]) for raw material (speed related to the gross cylindrical cage area (D x π x H). The guide vanes are positioned during the commissioning phase and then remain fixed.

In new roller mills only cage rotor separators with guide vanes should be installed as they produce a narrow PSD, represented as a steep slope in the range of 90 - 200 [μm]. Good ratios [%] R 200 [μm] / [%] R 90 [μm] are between 0.02 - 0.05 [-]. This means, while the target residue on 90 [μm] can be maintained, a much lower residue on 200 [μm] can be achieved. As in general, the quartz is found in the coarse fraction, a lower residue on 200 [μm] points to finer ground quartz particles, which in turn favors the burnability.

Increased gas speeds through the separator rotor provoke narrower, lower gas speeds wider PSD, resp. steeper or flatter slopes in the RRSB-chart. The PSD is also strongly influenced by the grindability of the material and the applied roller pressure.

On the other hand, cage rotor separators, due to the better classifying efficiency, produce less fines (= saving of energy) and produce coarser tailings (= more stable grinding bed).

Drying:

♦ The gas flow rate through the mill, resp. the gas mass, has to be maintained constant, to keep stable grinding/separation conditions. As the gas volume changes with the temperature (gas density), it is important to keep the mill exit temperature constant.

When processing material with higher moisture content, the mill exit temperature must be higher, and lower for material with less moisture.

Figure 8   Separators.

static separator   conventional rotor type   cage rotor type
                                                           with guide vanes

F = Feed
P = Product
T = Tailings
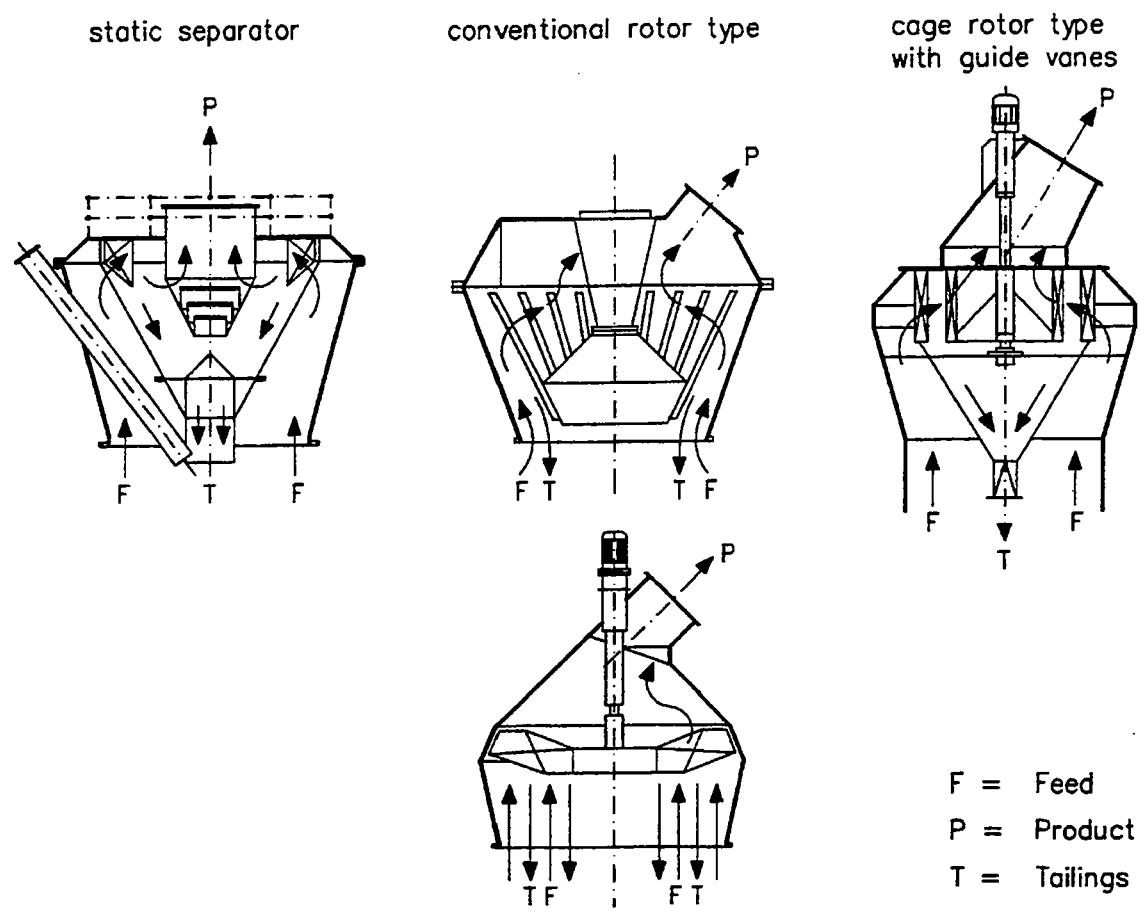
Figure 9   Particle Size Distribution.

Cage rotor type

$$\frac{R\ 200}{R\ 90} \approx 0.02-0.05$$

Static and conv. rotor type

$$\frac{R\ 200}{R\ 90} \approx 0.10$$

Particle size distribution (PSD) in the RRSB − Chart
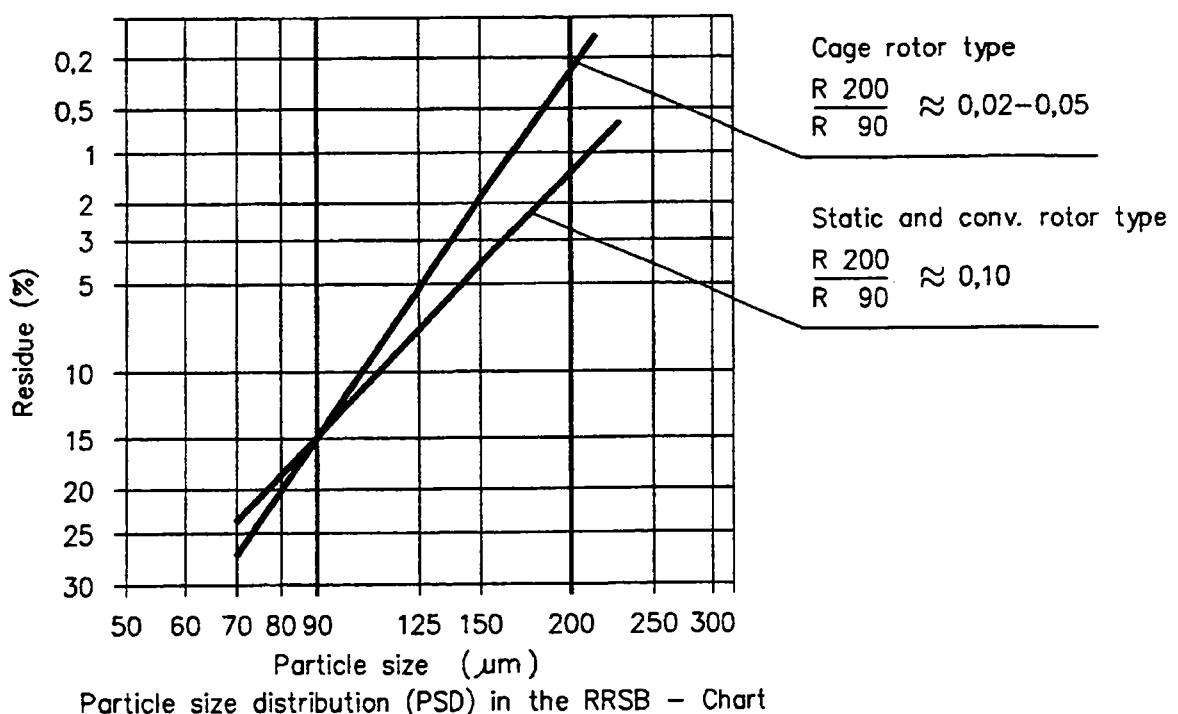
6. ROLLER MILL PERFORMANCE

6.1 Mill Throughput

For a given mill, the mill production rate depends mainly on:
* produced fineness
* grindability of feed material
* conditions of mill and system
* mill operation and control

Assuming that the feed material and its properties are given, the mill production rate changes in first order with changing fineness. The finer the product, the lower the possible mill throughput. On the other hand the feed granulometry to the mill has in general little or no influence on the production rate, specially in the coarse range. The impact of the feed granulometry is strongly operational (distribution of particles).

6.2 Mill Energy

The spec. mill energy consumption is a result of the absorbed mill power divided by the mill production. The absorbed mill power was discussed before.

The spec. energy consumption varies largely with the produced fineness. From the graph (fig. 10) the tendencies can be seen in case of raw materials. The graph shows the dependencies of the spec. energy consumption in relation to fineness and material hardness (grindability ranges for raw materials as defined by "Holderbank"). Spec. energy consumptions for roller mills are lower than for tube mills as the process is more efficient. Further the curves for roller mills are flatter than for tube mills, this means, the spec. energy consumption varies less for the same change of fineness.

6.3 Partial Load

The tendency in modern cement plant concepts is to adapt the raw mill production rate to the needs of the kiln. Therefore the roller mill often operates at partial loads. At lower mill throughputs the spec. energy consumption increases.

6.4 Fan Energy

The energy consumption of a roller mill system consists mainly of two large consumers, the mill and the mill fan. The energy consumption of the mill fan is generally in the same order of magnitude as for the mill itself. The fan energy can be influenced by two prime factors:
* gas flow rate
* pressure loss over mill and system

The gas flow rate can hardly be changed, therefore the pressure loss is predominant for the portion of energy consumed, where the pressure loss over the mill is the most important. The pressure loss of large mills increases compared to small mills. A maximum effort should be made to lower the pressure losses. Fig. 11 shows a normal range of pressure loss for vertical roller mills for raw material.

**Figure 10   Roller Mill - Performance / Raw Material**

Grindability ratings   ("Holderbank" – Standard)
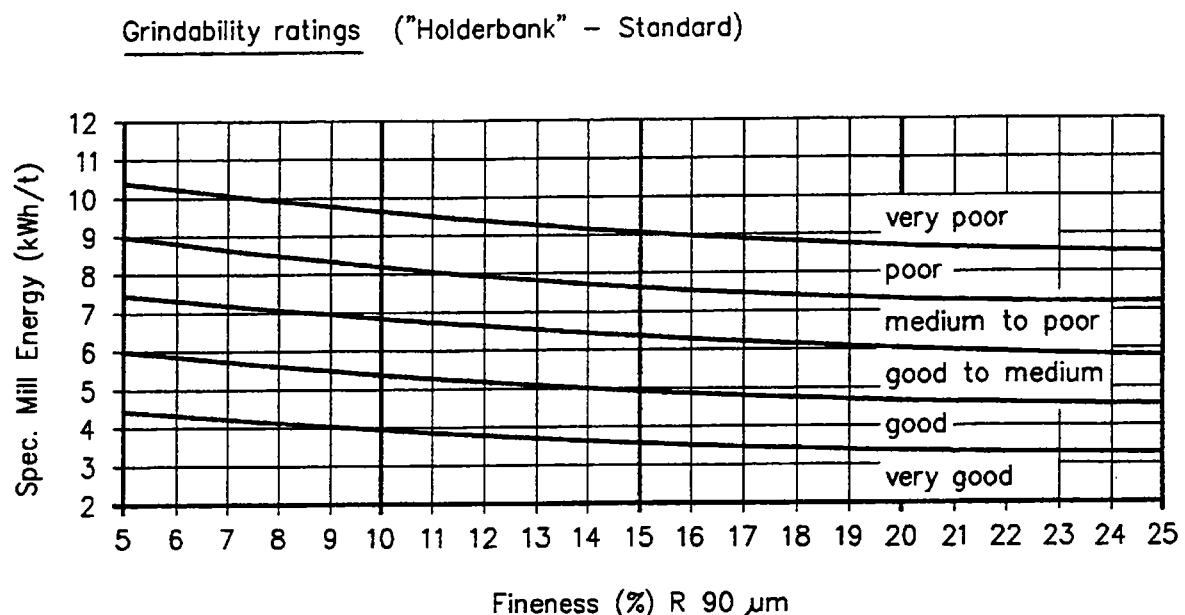
Figure 11   Roller Mill - Pressure Loss / Raw Material
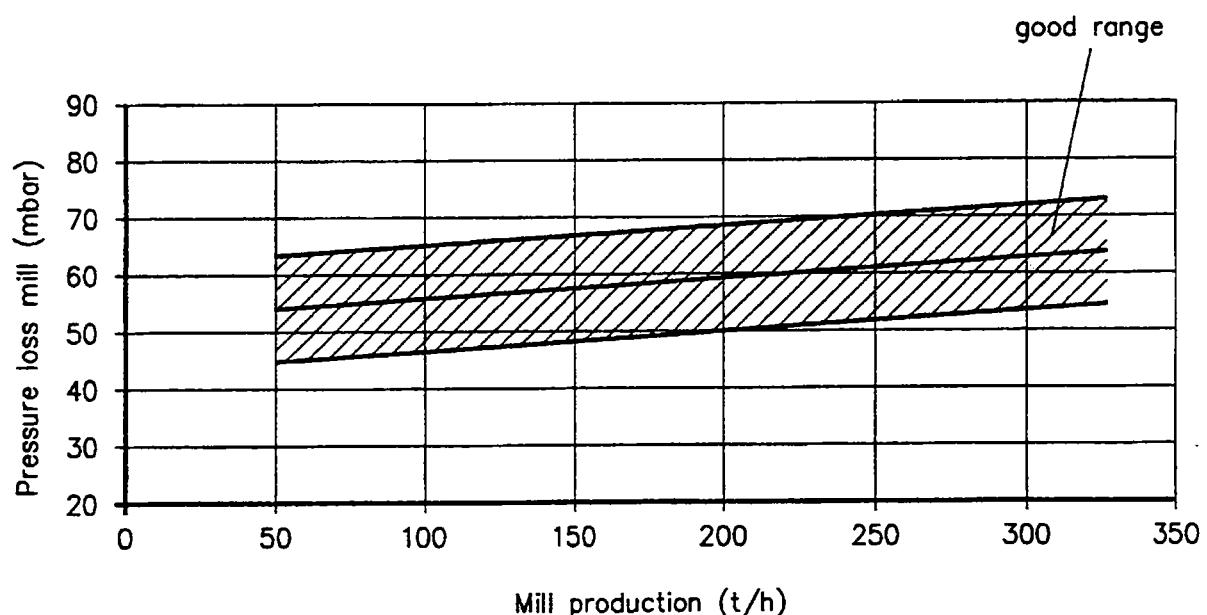
7. DESIGN AND FEATURES OF VARIOUS SUPPLIERS

7.1 Gebr. Pfeiffer (fig. 12)

♦ **Make:**

MPS   3750   A
$\downarrow$
Series
$\rightarrow$ Diameter [mm] *)

♦ **Series: *)**
A - old series - Diameter = D_M (grinding track)
B - new series - Diameter = D_B (outside grinding track)
C - version for cement
K - version for coal

♦ **Application:**
* Raw material
* Coal
* Pozzolano / Trass
* Cement

♦ **Sizes:** up to MPS 4850 A, 350 [t/h] raw material

♦ **Dimensioning parameters:**

D_M	= 0.8 x D_B	[m]
c	= 44.5 ... 47.5	[-]
k	≤ 450	[kN/m²]
m	» 0.1	[-] raw material

♦ **Design features:**
* Roller and grinding bed 15 deg inclined, concave grinding path
* 3 rollers for all sizes
* Rollers suspended at a pressure frame
* Hydraulic actuated at a pressure frame
* Pull rods inclined to absorb torque, mill housing not affected with horizontal forces
* High-efficiency separator type SLS

♦ **Operation:**
* Start-up with auxiliary drive, rollers statically on grinding table
* Normally large size mill casing and low pressure losses of gas flow
* Series B operates with higher gas flow rates and higher roller pressures than series A

♦ **Maintenance:**
* Swing-lift device for retraction and servicing of the rollers

♦ **Specialties:**
* Lower part of mill (without separator) to be used as a pregrinder for clinker in connection with a ball mill

◆ <u>Licensees:</u>

    ＊   Former license to FLS

    ＊   Babcock

    ＊   Allis-Chalmers

Figure 12   **Gebr. Pfeiffer**
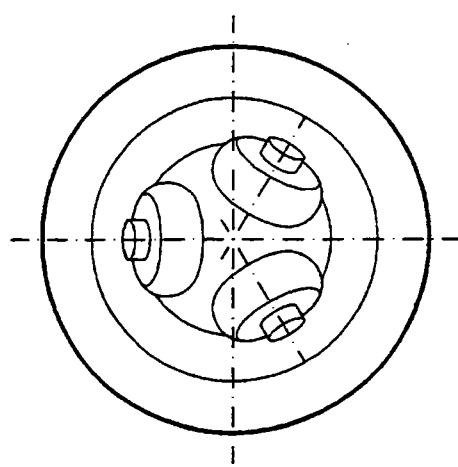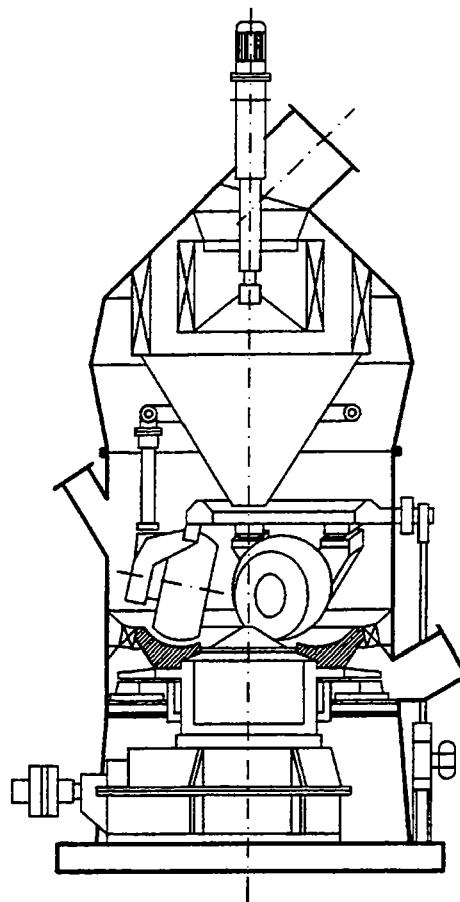
7.2   Loesche (fig. 13)

♦ Make:

```
LM    38.    4    50
 |     |     |    ↓
 |     |     |    Module
 |     |     |
 |     |     →    No of rollers (2,3,4)
 |     —     →    Table diameter (nominal) in [dm]
 —     —     →    Loesche-Mill
```

♦ Application:
  * Raw material
  * Coal
  * Pozzolana
  * etc.

♦ Dimensioning parameters:
  (Loesche mills vary in geometrical ratios for the different mill sizes.)

levers rocker arm	F_2	$\approx 0.8 ... 0.85 \times F_1$	[kN]
diameter grinding path	D_M	$\approx 0.81 ... 0.83 \times D_N$	[m]
speed constant	c	$= 50.5 ... 53.5$	[-]
spec. roller pressure	k	≤ 880	[kN/m^2] operation
friction factor	μ	≈ 0.1	[-] raw material

♦ Sizes: up to LM 59.4 for 700 [t/h] raw material

♦ Design features:
  * Airlock in general as triple gate, larger mills double triple gate
  * High-efficiency separator, jalousie type LJKS
  * Conical rollers 2, 3 or 4 according to mill capacity
  * Rocker arm with hydraulic cylinders to exert the roller pressure
  * Hydraulic cylinders with nitrogen accumulators
  * Modular design; hydropneumatic units can be combined with various mill sizes according to throughput or drying needs.

♦ Operation:
  * Rollers can be lifted from grinding track for low torque start-up of the mill
  * Two of four rollers can be unloaded for partial capacity operation of special operating conditions
  * Generally high pressure loss across mill, can be optimized with external circulation
  * Generally high false air rates due to rocker arm openings in mill casing

♦ Maintenance:
  * Practical swing-out device for roller servicing and replacement
 * Rocker arm sealings need carefully be maintained

♦ Licensees:
  * UBE Japan
  * formerly also Fuller, today expired due to take-over by FLS

♦ Future:
  Mill has been adapted, specially through UBE, for grinding blast furnace slag and cement

Figure 13   Loesche
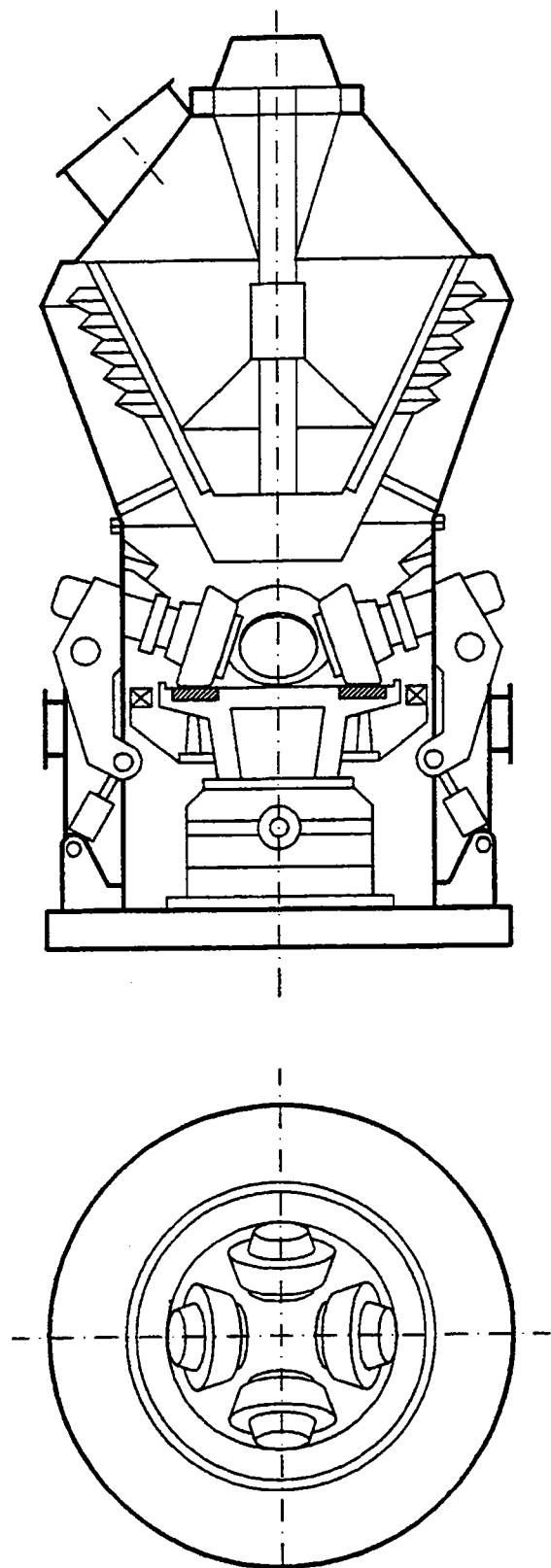
7.3   Fuller - Loesche (fig. 14)

◆ Make:

LM   38.   4   30
| | | ↓
| | | Module
| | |
| | →   No of rollers (2,3,4)
| —   →   Table diameter (nominal) in [dm]
—   —   →   Loesche-Mill

◆ Application:
    *   Raw material
    *   Coal
    *   Pozzolana
    *   etc.

◆ Dimensioning parameters:
    (Fuller-Loesche mills vary in geometrical ratios for the different mill sizes.)

levers rocker arm	F_2	$\approx 0.8 \dots 0.85 \times F_1$	[kN]
diameter grinding path	D_M	$\approx 0.81 \dots 0.83 \times D_N$	[m]
speed constant	c	$= 50.5 \dots 53.5$	[-]
spec. roller pressure	k	≤ 880	[kN/m^2] operation
friction factor	μ	≈ 0.1	[-] raw material

◆ Sizes: up to LM 59.480 for 700 t/h raw material
    Fuller has many different roller sizes for the same mill size. Therefore the dimensions of rollers have to be indicated for the calculation of a specific mill type.

◆ Design features:
    *   In general the same as the Loesche mill
    *   High-efficiency separators type O-SEPA (license of ONODA) are installed. Also features of the SEPAX separators are available since the take-over through FLS.

◆ Operation:
    *   Mainly same as Loesche mills

◆ Specialties:
    Fuller offers often roller mill systems with fresh air dampers. These systems are generally very difficult to operate. It is recommended to install in any case a gas recirculation duct for a good controllability of the systems.

Figure 14   Fuller - Loesche
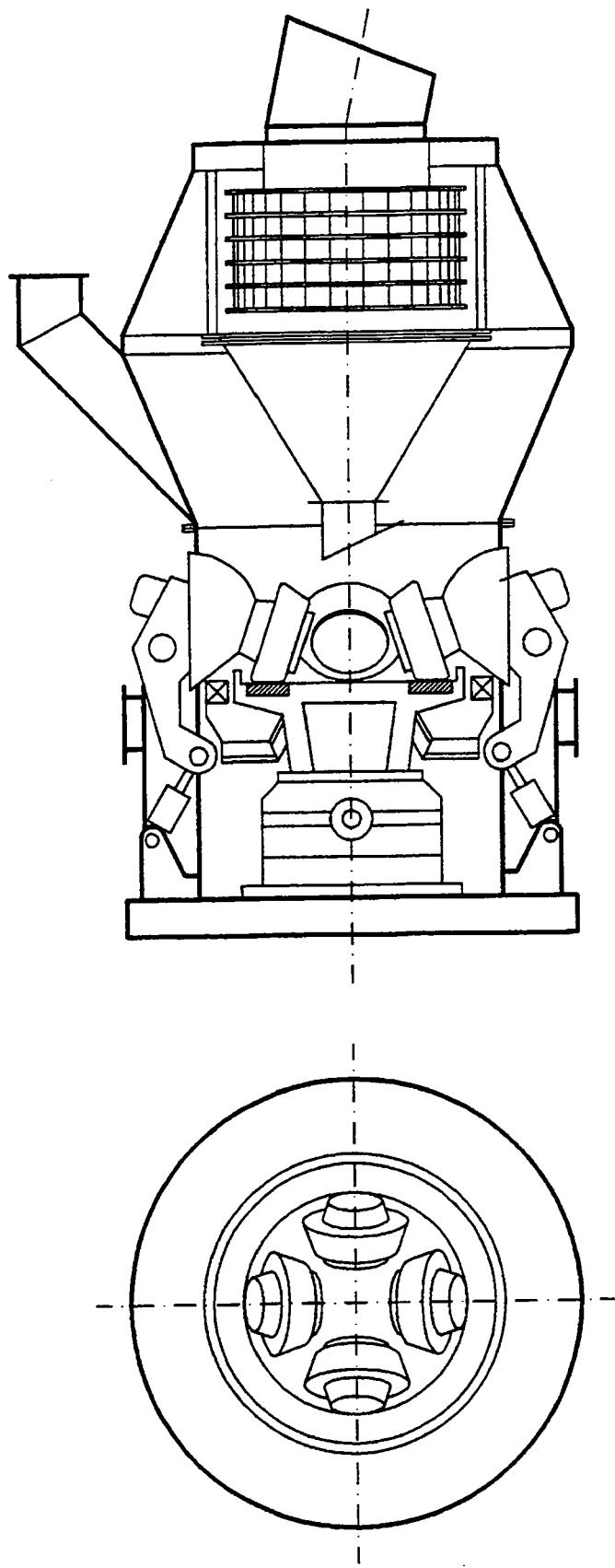
7.4   FLS (fig. 15)

◆ Make:

ATOX 50
↓
Table diameter $D_T = D_N$ (nominal) [dm]

◆ Application:
* Raw material
* Coal

◆ Dimensioning parameters:
Atox mills are totally geometrical:

D_M = 0.8 x D_T [m]

D_R = 0.6 x D_T [m]

W_R = 0.2 x D_T [m]

c   = 50.1   [-]

k   = 800   [kN/m²] dim. / ≤ 700 [kN/m²] operation

μ ≈ 0.1   [-] raw material

◆ Sizes: available up to ATOX 60,   660 [t/h] of raw material, built up to ATOX 50

◆ Design features:
* No. of rollers: always 3
* Axles of the rollers interconnected in a rigid center yoke
* Hydraulic cylinders with pull rods connected to each axle tip
* Pull rods arranged outside grinding area
* Roller axis with 3 degrees lag of the table center in rotating direction
* Tangential thrust absorbing torque arms and bearings fixed to the mill body
* High-efficiency cage rotor separator SEPAX type (RAR...) with adjustable guide vanes
* Nozzles of louvre ring adjustable with inserts

◆ Operation:
* Rollers can be lifted-up for start-up of grinding table
* Compact mill housing with reduced false air leakage
* Standard systems include a gas recirculating duct
* External material circulation installed as normal

◆ Maintenance:
* Roller segments uniformly worn due to flat rollers and table
* Roller segments can be turned around
* Roller segments exchange possible by lifting-up hydraulically rollers with yoke

◆ Future:
* Tests with grinding of cement performed
* FLS favors commercializing the OK mill (Kobe/Onoda) for cement grinding

Figure 15   FLS - ATOX
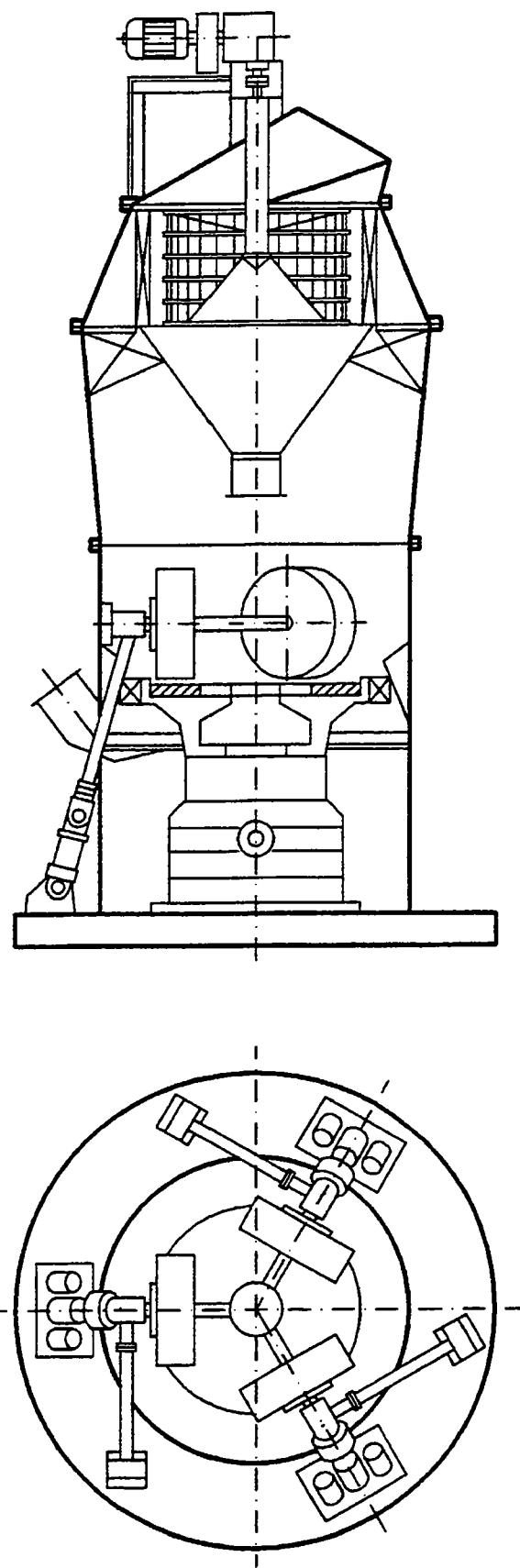
7.5 Polysius (fig. 16)

♦ **Make:**

RM 46/ 26/ 370

| | | | ↓
| | | Diameter separator rotor [cm]
| | |→ Diameter rollers D_R [dm]
| |— → Diameter grinding table D_T [dm]
|
|— — → R-Raw Mill
. K-Coal Mill

♦ **Application:**
  * Raw material
  * Coal
  * etc.

♦ **Dimensioning parameters:**

$D_{M1} \approx 0.75 \times D_N$ [m]

$D_{M2} \approx 0.35 \times D_T$ [m]

c $= 38 ... 42$ [-] related to $D_M = \dfrac{D_{M1}+D_{M2}}{2}$

k ≤ 1100 [kN/m^2]

$\mu \approx 0.1$ [-]

♦ **Sizes:** up to RM 60/29

♦ **Design features:**
  * Mill feed sealing through rotary air lock
  * 2 twin rollers for all sizes with double grooved grinding table
  * Each roller pair with a yoke
  * Hydraulic cylinders with pull rods, fixed to hooks at yoke tips
  * Pull rods arranged outside grinding area
  * One pull rod is generally fix, the other is the working side which adjusts the roller pressure
  * High-efficiency separator type SEPOL

♦ **Operation:**
  * Start-up of mill with auxiliary drive, as rollers can not be lifted hydraulically
  * Nozzle ring openings adjustable to adapt gas speed to operating conditions (normally v = 20 ... 50 [m/s] adjustable)
  * External circulation preferred, installed capacity ≤ 200 [%] of mill throughput

♦ **Maintenance:**
  * Rollers (twin rollers with yoke) turnable for more even wear
  * Rollers retraction by crane through large doors in mill casing
  * Nozzles for louvre ring adjustable from outside
  * Pull hooks at the roller yokes adjustable in position for distribution of grinding force to the two rollers

♦ **Future:**
  * Roller mill tested and adapted for grinding of cement

Figure 16   Polysius
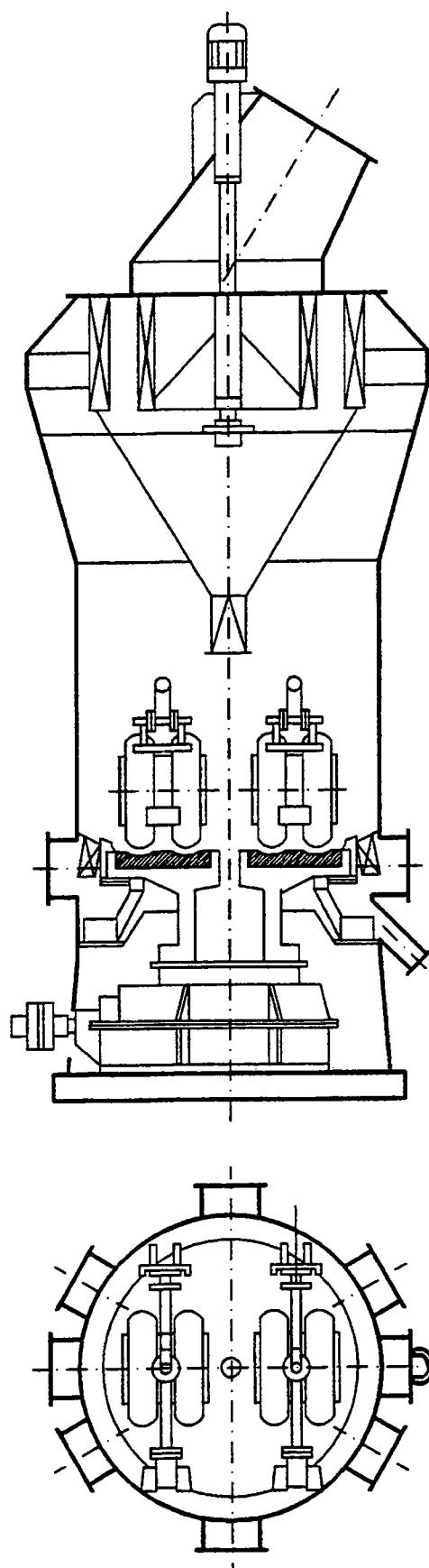
8. MAINTENANCE AND SERVICING

Today's roller mills for raw grinding have to run through for a long time (weeks, months) without interruption to cope with the kiln and plant's needs. The reliability has been greatly improved, so that usually only planned stops are necessary.

8.1 Wear

What concerns the wear of the grinding tools (roller tyres / segments and table liners) one does hardly talk about [g/t] of wear, but service lives of "years'. To change the main wear parts, a mill stop is needed. This should be one of the yearly stops. Spare rollers / tyres / segments and table liners are preferably in stock and can be exchanged / replaced upon a planned stop. In certain cases (e.g. Polysius, FLS) the rollers can be turned around after half the service life.

Roller exchanging facilities:

♦ Loesche, Fuller, Ube, Mitsubishi, Raymond:
Rocker arm type mills add a servicing hydraulic cylinder in order to swing out the roller. The casing opening has to be prepared for. The swung-out roller can be lifted by an overhead crane.

♦ Polysius
There are crane rails fix installed within the mill. The large side doors are opened, a connection of the rails with the outside crane is done and the crane hoist can enter the mill. The twin rollers form a unit together with a yoke. Yoke and rollers are lifted up and moved at a crane out of the mill. Sufficient space for the handling of the roller set (quite heavy for large mills) has to be provided.

♦ Gebr. Pfeiffer
Pfeiffer mills can be fitted with a swing-lift device. A support with a central column is fitted to the rollers and the swing-lift device outside the mill. The swing lift device can haul the roller out of the mill where a crane will take over the roller.

♦ FLS
A crane rail is introduced into the mill, directly over one roller. A hoist lifts the roller up and moves the load over the rail to an external rail connection to the servicing area.

8.2 Inspections

A continuous operation of a roller mill can only be achieved if the critical areas are regularly inspected and serviced.

♦ During operation:
  * Vibrations of gear drive and mill casing
  * bearing and oil temperatures
  * lubrication systems

♦ During stop:
  * wear parts (table, rollers, nozzles, dam ring, bearings exposed to material/gas flow, feed gate, etc.)
  * bearings, roller bearings, bearing sealings
  * air locks, sealing air system for bearings
  * lubrication systems (filters, oil conditions)
  * hydraulic pressure system, include. accumulators
  * gear device, clutch

**Figure 17a   Servicing Facilities - Loesche, Fuller, UBE, Mitsubishi**

opening in casing
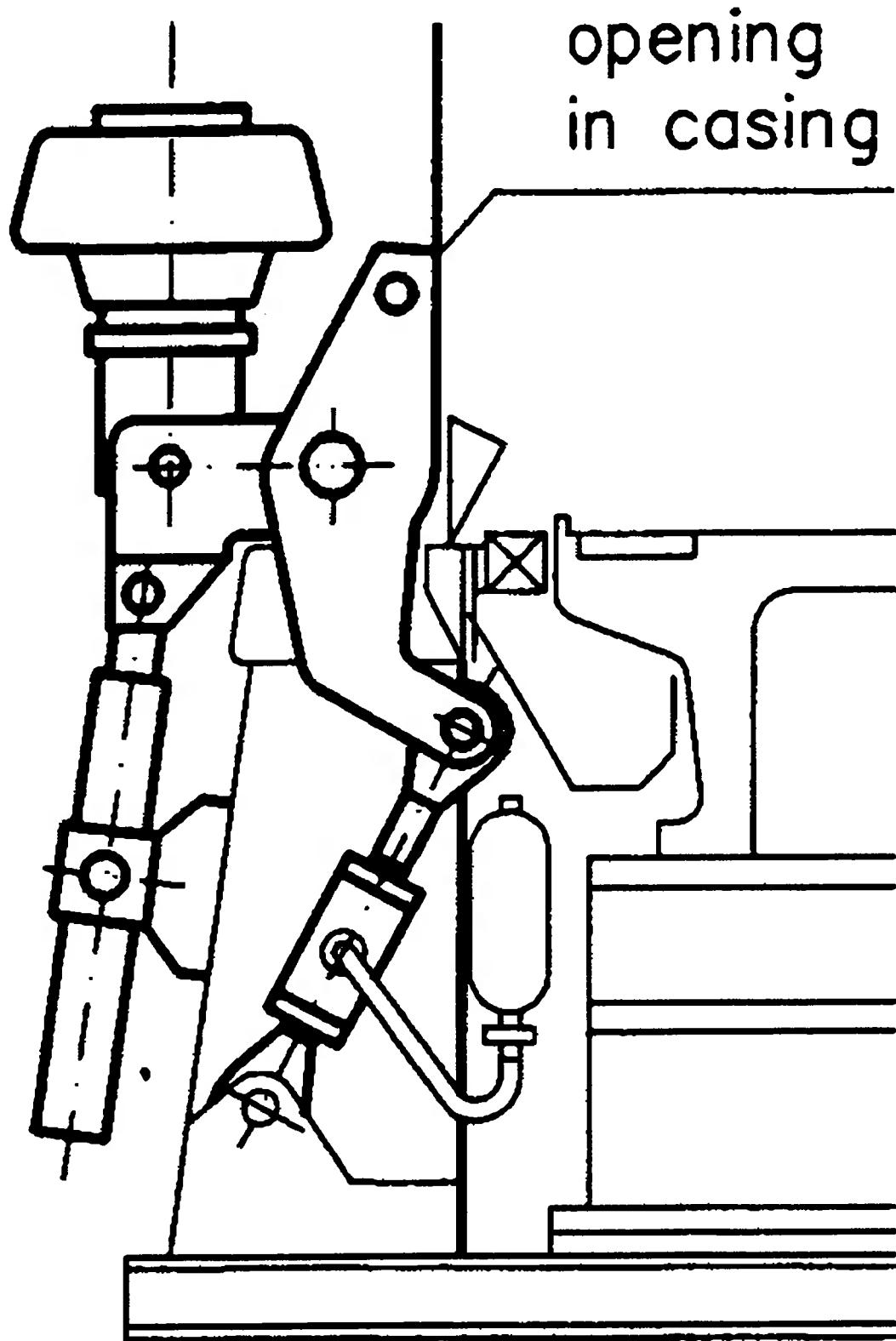
Figure 17b   Servicing Facilities - Gebr. Pfeiffer

crane

support
fixture

central
column

lift and
swing device
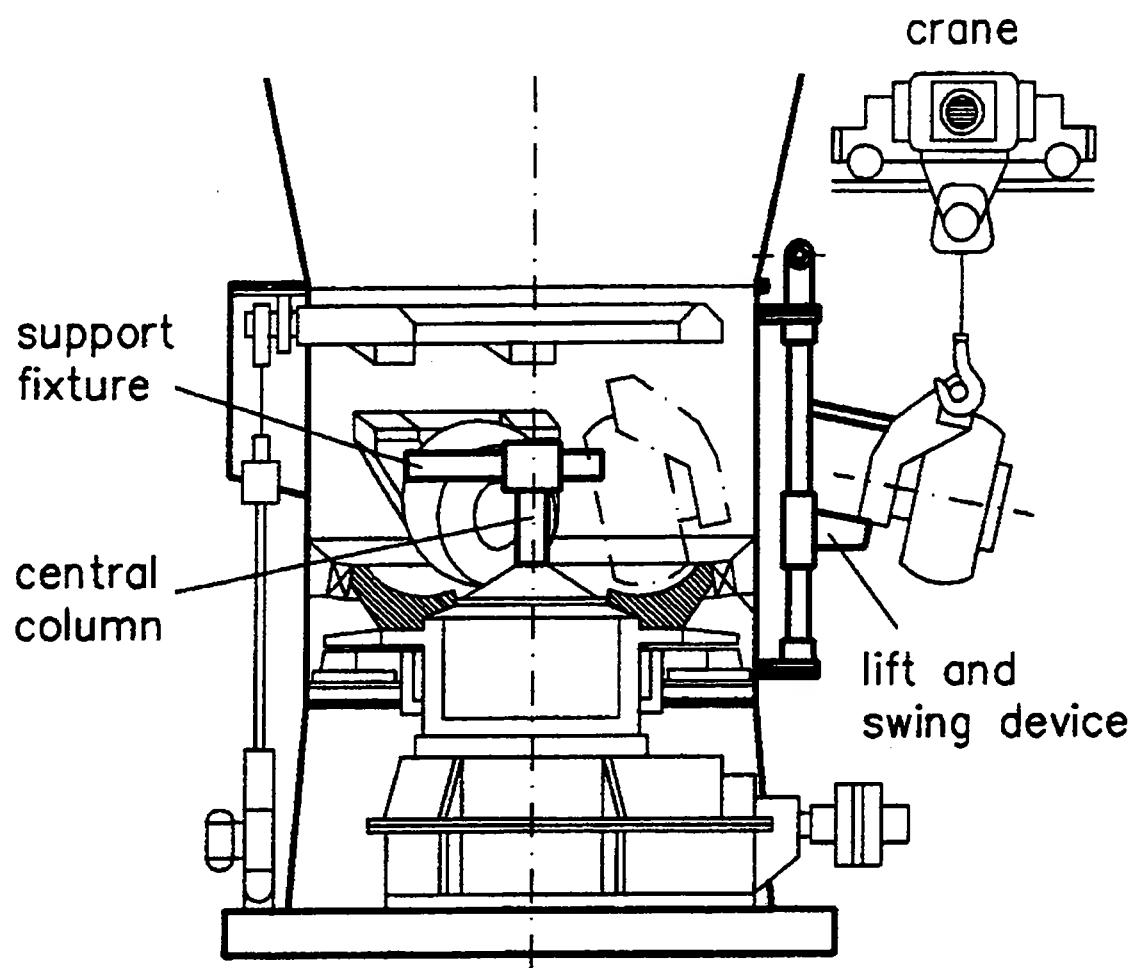
Gebr. Pfeiffer

Maintenance door
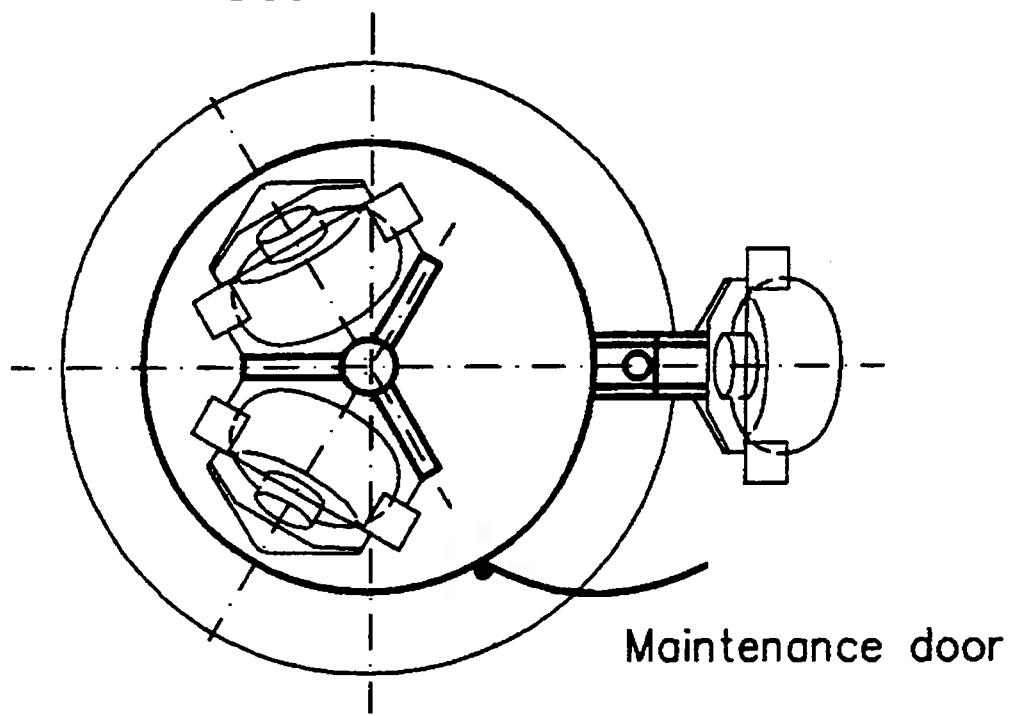
**Figure 17c   Servicing Facilities - Polysius**
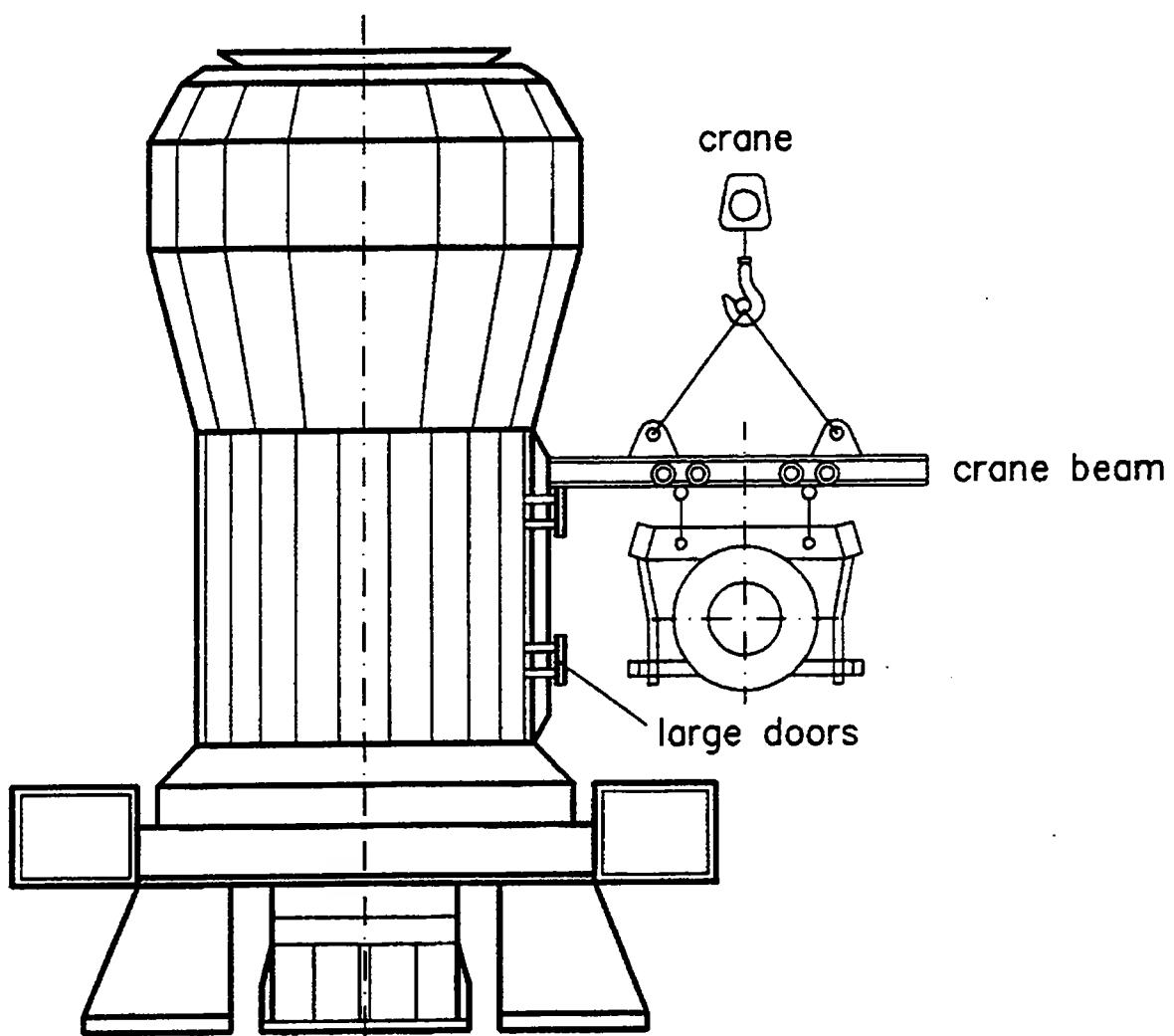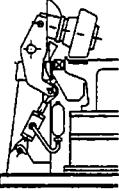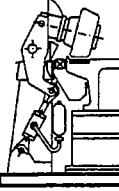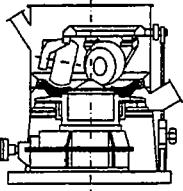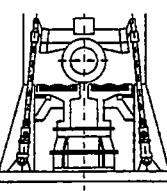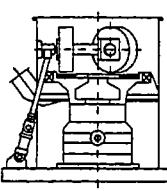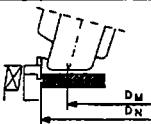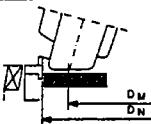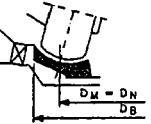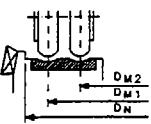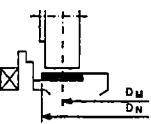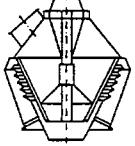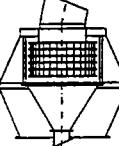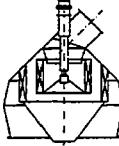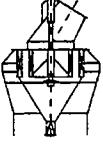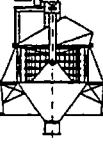
Figure 18   Suppliers - Design Roller Mills

SUPPLIER	Loesche	Fuller – Loesche	Gebr. Pfeiffer	Polysius	FLS
Make	LM	LM	MPS	RM	ATOX
Mill design					
Tension device					
– Type	Rocker arm	Rocker arm	Pressure frame	Yoke	Center yoke
– Arrangement	Outside	Outside	Pull rods / outside	Pull rods / outside	Tension rods / outside
– Roller exchange	Aux. tilting device	Aux. tilting device	Swing – lift device	Crane	Crane
Nr. of Rollers	2 / 3 / 4	2 / 3 / 4	3	2 x 2 (twins)	3
Grinding tools					
Roller inclination	15 deg	15 deg	15 deg	—	—
Grinding path	$D_M \approx 0.83 \cdot D_N$		$D_M \approx 0.80 \cdot D_B$	$D_{M1} \approx 0.75 \cdot D_N$ $D_{M2} \approx 0.35 \cdot D_N$	$D_M \approx 0.80 \cdot D_N$ $D_R \approx 0.60 \cdot D_N$
Roller width	$W_R \approx 0.39 \cdot D_R$	$W_R \approx 0.34 \cdot D_R$ 1)		$W_R \approx 0.28 \cdot D_R$ 1)	$W_R \approx 0.20 \cdot D_R$
Separator					
Type	LKS	HEC (O-Sepa) Fuller SEPAX (FLS)	SLS	SEPOL	SEPAX RAR